【Science and engineering（Engineering Ⅱ）】

Production and Control of Super-Dense Plasmas towards an Innovative Ignition Regime for a Fusion Reactor

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【Outline of survey】

The goal of this project is to propose a scientific model for ignition with super-high density and low temperature, which is different from the conventional scenario with low density and high temperature. Fusion plasmas with super-high density and low temperature reduce serious heat load on the first wall and improve performance of confinement including fusion products, i.e., alpha particles. Consequently, this scenario is expected to mitigate the requirements of a fusion reactor.

We have found the operational condition whereby particle diffusion is suppressed in the experiment with highly efficient fueling by solid hydrogen pellets on the Large Helical Device. The plasma density has reached 10 times 10 to the 21st per cubic meter, which is ten times higher than the usual breakeven condition.

This project tackles elemental issues, i.e., establishment of a control method to sustain super-high density plasmas in steady state, impurity screening consistent with helium ash exhaust, reduction of heat load on the wall by control of detached plasmas and clarification of confinement properties required for the control of a thermal instability in a fusion reactor. We aim at an innovative ignition scenario with a temperature of 80 million degrees and a density of 6 times 10 to the 20th per cubic meter of the density in contrast to the conventional scenario with 200 million degrees and 1.5 time 10 to the 20th per cubic meter, which is anticipated to reduce the engineering demands in a fusion reactor.

【Expected results】

The goal is establishment of an operational regime which cannot be realized in tokamaks such as ITER. This innovative approach is possible by scientific exploration only in helical system.

The anticipated outcome of this project has the potential to mitigate these requirements significantly. Progress in key elements suggested by the scientific results to date will provide sufficient materials to assess the applicability of a super-dense plasma to a fusion reactor.

【References by the principal investigator】

- H.Yamada et al., "*Characterization and Operational Regime of High Density Plasmas with Internal Diffusion Barrier Observed in the Large Helical Device*" Plasma Physics and Controlled Fusion, Vol.49, pp.487-496 (2007)
- R.Sakamoto et al., "*Repetitive Pellet Fueling for High-Density/Steady-State Operation on LHD*" Nuclear Fusion, Vol.46, pp.884-889 (2006)

【Term of project】 FY2008－2012	【Budget allocation】 122,200,000 yen (direct cost)

【Homepage address】 http://iis.lhd.nifs.ac.jp